



Climate Change

Evaluation and Quality Control Function of the C3S

Francisco Doblas-Reyes (BSC-CNS and ICREA)
on behalf of the C3S EQC team

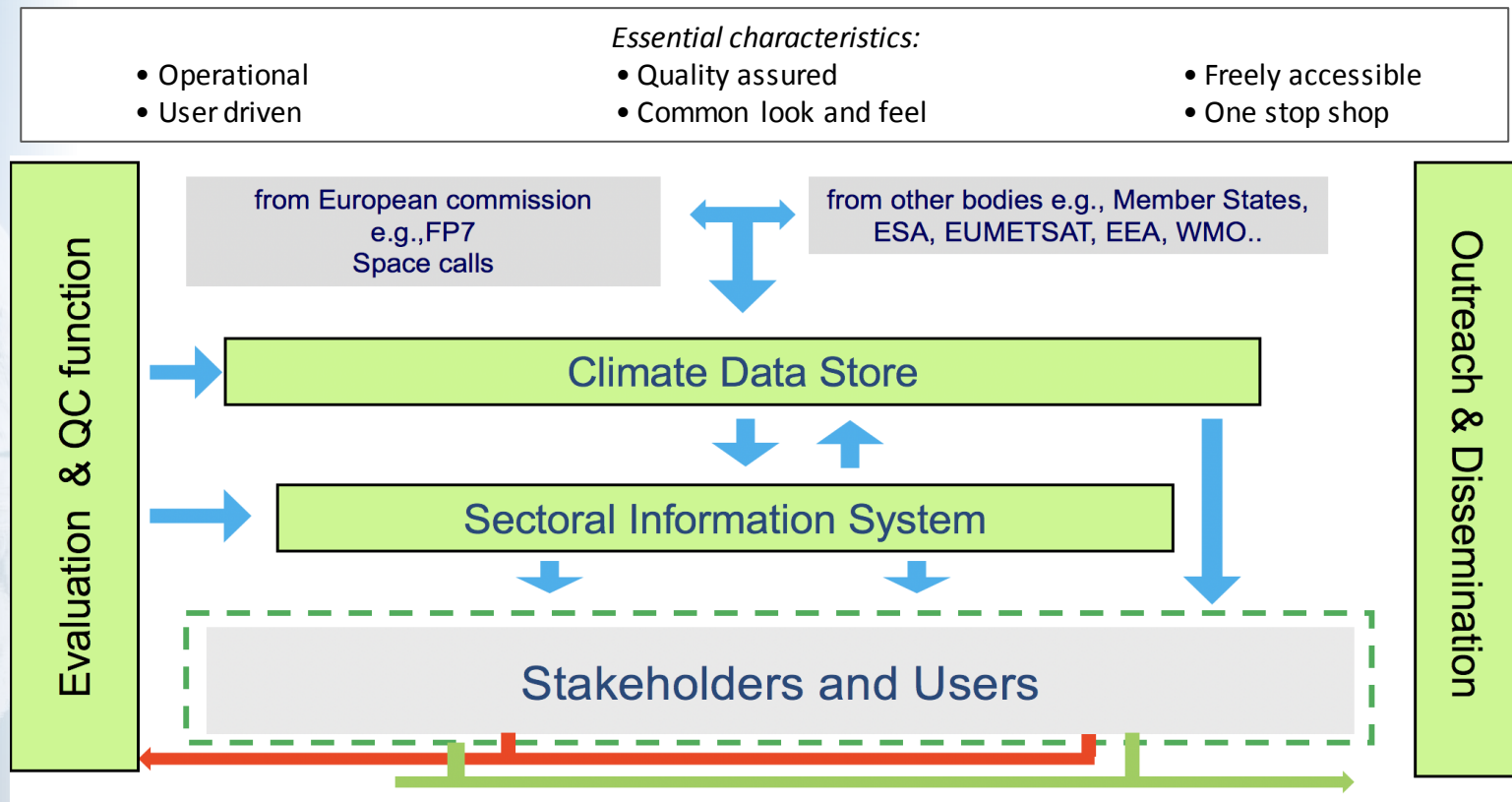
EMS annual meeting 2019





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C3S in a nutshell

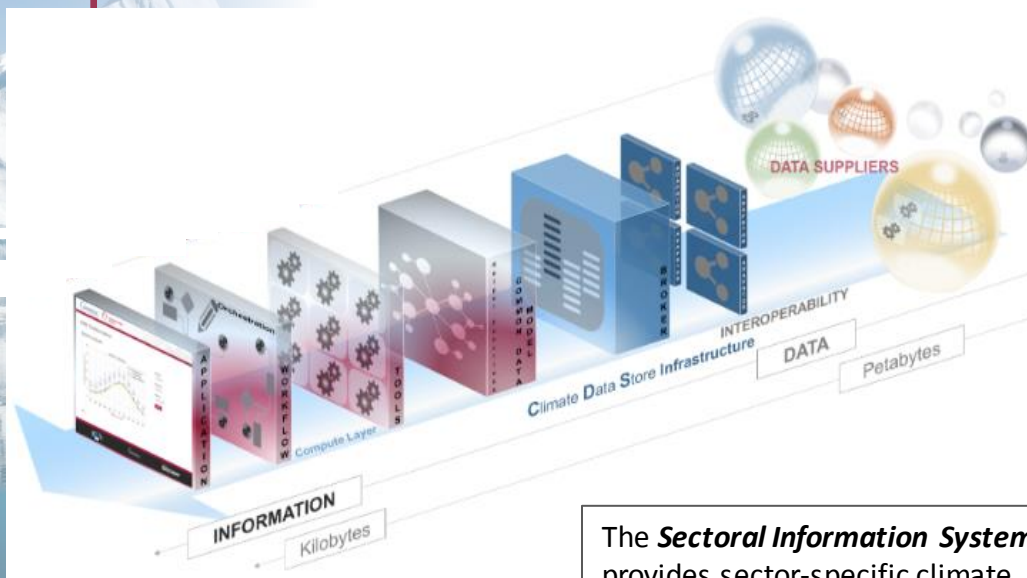




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CDS and SIS components of C3S

The **Climate Data Store (CDS)** provides a single point of access to a wide range of climate datasets, namely satellite and in-situ observations, reanalyses, seasonal forecasts and climate projections.



The **Sectoral Information System (SIS)** provides sector-specific climate indicators and tools to support public and commercial applications, policy development and strategic planning.





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Evaluation and quality control in the C3S

The **Evaluation and Quality Control (EQC)** function provides an overarching quality assurance for the whole CDS and SIS components of the C3S service.

C3S_51 Lot 2
ECVs/Observations

EQCO

C3S_51 Lot 3
Seasonal Forecasts

QA4Seas

C3S_51 Lot 4
Climate Models

DECM

C3S_52 Lot 2
SIS

SECTEUR

C3S_512

- CDS datasets
- CDS toolbox
- Overall CDS service

C3S_511

- Independent assessments of ECVs

C3S_513

- SIS data, services
- Workflows and applications
- URDB and analysis

The aim of the EQC is to guarantee that the C3S products are:

- ☐ Reliable and usable
- ☐ Fit for purpose
- ☐ User relevant
- ☐ Scientifically and technically quality evaluated
- ☐ Provided with easy-to-access, clear and complete quality information

User Engagement



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E Q C F O R C D S



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Evaluation and quality control of the CDS

Such a complex infrastructure requires an ***Evaluation and Quality Control (EQC)*** function providing an overarching quality assurance service. It addresses the whole CDS and includes:



CDS datasets: provide information about the technical and scientific quality and fitness-for-purpose, along with independent assessment of the datasets



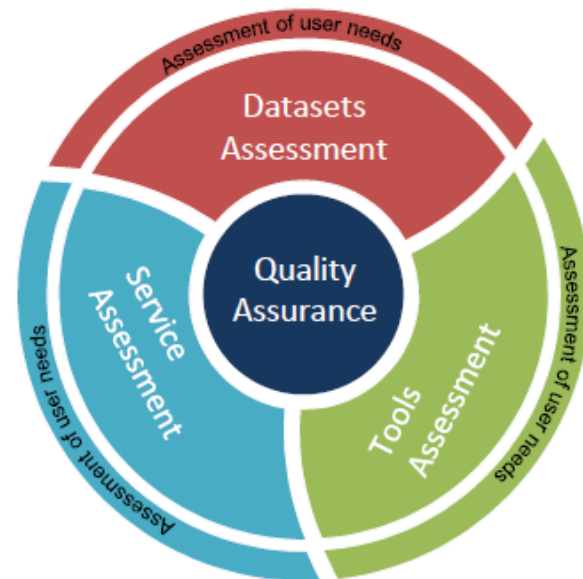
CDS Toolbox: assessment of maturity and fitness for purpose of the software provided to explore the datasets



CDS service: performance assessment of the CDS infrastructure (e.g. speed, responsiveness, system availability)



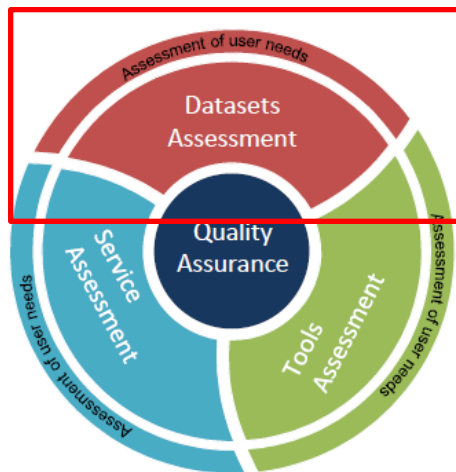
CDS users: user requirement assessment to measure users' satisfaction with the CDS. Map evolving user needs into viable user requirements to ensure a user-oriented evolution of the CDS





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EQC OF THE CDS DATASETS





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EQC of the CDS datasets

QAR available
in the CDS

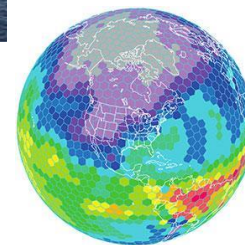
The quality assessment of the CDS datasets is collected in **Quality Assurance Reports (QARs)**. The QAR includes a variety of dataset documentation, according to provider indications, that is independently reviewed by the EQC team, including an independent assessment of the data

A challenge: the CDS datasets encompass a wide variety of data types:

- ☐ Satellite observations
- ☐ In-situ observations
- ☐ Global and regional reanalyses
- ☐ Seasonal forecasts
- ☐ Global and regional climate projections

This poses challenges to provide a ***seamless and homogeneous EQC information*** for the whole CDS datasets

To overcome this issue a ***synthesis table*** is published in the CDS web portal





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Synthesis table

Based on information obtained by providers and reviewed by EQC

INTRODUCTION

Dataset overview

Temporal and
spatial coverage
and resolution

Providers

Dataset version

Record update

USER DOCUMENTATION

User guide

Scientific
methodology

Uncertainty
quantification

Validation

Inter-comparison

ACCESS

Toolbox
compatibility

Archiving

Based on results from the EQC assessment

INDEPENDENT ASSESSMENT

Data check

Expert evaluation

Maturity matrix

Summary of the
independent
assessment

- ☐ The synthesis table is a tool to organise and homogenize the EQC information
- ☐ Its layout is shared by all data types
- ☐ Each box has a link to display the specific EQC information of interest



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Independent assessment framework

Independent
Fully traceable
Replicable
Transparent to data provider

Dataset maturity

Independent maturity assessment.
Implement and adapt EU-framework
Standard quality functions (from
QA4ECVs, Core-Climax, GAIA-CLIM,
ESIP IQC)



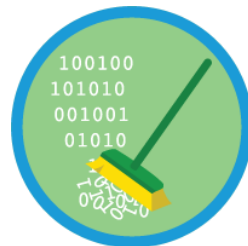
Fitness4Purpose, through
scientific analysis relevant to users

Basic statistical properties
Trend detection
Model evaluation
Performance metrics
Cross-comparison



Data check

Data and metadata completeness,
consistency, physical plausibility and
compliance with community
standards



Use of open source community software for reproducibility, versioning and optimal engagement



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Display of the dataset EQC information

Overview Download data Documentation **EQC**

Processing level ?

☒ Level 3 ☐ Level 4

Variable ?

☐ Ozone mole content ☐ Ozone mixing ratio
☒ Ozone concentration ☐ Ozone concentration anomaly
☐ All ozone variables from nadir sensors

Vertical aggregation ?

☐ Total column ☐ Tropospheric column
☒ Vertical profiles from limb sensors ☐ Vertical profiles from nadir sensors

Sensor

☐ Combination of MIPAS, GOMOS, SCIAMACHY and OSIRIS sensors
☐ Combination of 15 sensors using gap-filling assimilation methods
☒ ACE (Atmospheric Chemistry Experiment)
☐ GOME (Global Ozone Monitoring Experiment-I)
☐ GOME2A (Global Ozone Monitoring Experiment-II onboard METOP-A)

- ☐ User selects the dataset and variable of interest
- ☐ The user is then offered the option to access the related EQC information by clicking on the appropriate tab
- ☐ The information is presented through a web page displaying the synthesis table; the webpage is created dynamically using the latest information available

Show EQC information





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Display of the dataset EQC information

Based on information obtained by providers and reviewed by EQC

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Management of the dataset EQC info

Dataset overview

Temporal and
spatial

Providers

Dataset version

Record update

INTRODUCTION

ECV: Earth radiation budget

Physical Quantity Name: Active Fire Maps

Version number: v1.0

DOI

<https://climate.copernicus.eu/>

Organisation(s): My organisation

Processing Level of product:

Level 2

Timeliness

Primi igitur omnium statuuntur Epigonus et Eusebius ob nominum gentilitatem oppressi: praedictus enim Montium sub ipso vivendi termino his vocabulis appellatos fabricarum cupisse tribunos ut administrata futurae molitioni polliceris.

Point of contact

Name

John Doe

Email

john@dd.com

Product status: Completed

Date product last updated

Fri, 05/11/2018 - 12:00

Date product made available

Tue, 04/17/2018 - 12:00

Description of any further updates to the product

Yes

Point of contact

Name

Email

Product status

Date product last updated

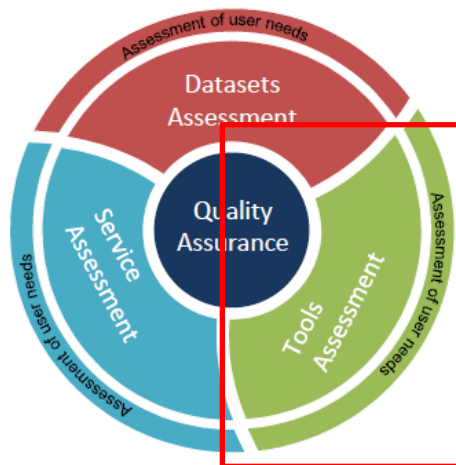
Date product made available

- ☐ The synthesis table web pages are built dynamically, showing the information stored and managed by the EQC Content Management System (CMS)
- ☐ The user selections form the query to interrogate the database managed by the CMS



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EQC OF THE CDS TOOLBOX





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CDS Toolbox

The Toolbox is a suite of software tools that allows the users to explore (e.g. subsetting, averaging, visualizing) the CDS products and develop their own applications based on the CDS data content.

Workspace and editor

Toolbox editor

Applications Data Documentation

Search for app or example

your workspace

- 51 Calculate zonal means
- 11 Calculate time mean and standard deviation
- 21 Calculate regional mean and anomalies
- 03 Extract time series and plot graph
- 01 Retrieve data - Training
- 02 Plot map-1
- 02 Plot map
- 00 Hello World

examples

- 00 Hello World
- 01 Retrieve data
- 02 Plot map
- 03 Extract time series and plot graph
- 11 Calculate time mean and standard deviation
- 12 Calculate climatologies
- 21 Calculate regional mean and anomalies
- 31 Calculate trends
- 41 Calculate GDD
- 42 Use cdo functions
- 51 Calculate zonal means
- 52 Format maps to allow visual comparison

52 Format maps to allow visual comparison

Layout

```
import cdstoolbox as ct

@ct.application(title='Format maps to allow visual comparison')
@ct.output.figure()
def ice():
    """
    Application main steps:
    - retrieve a sample dataset (sea ice area fraction)
    - compare sea ice area fraction in August 1992 and August 2003 on two different maps.
    """

    sic = ct.catalogue.sample('OSTIA', 'sic', 'day')
    time_92 = '1992-08-03'
    time_03 = '2003-08-03'
    sic_1992 = ct.cube.select(sic, time=time_92)
    sic_2003 = ct.cube.select(sic, time=time_03)

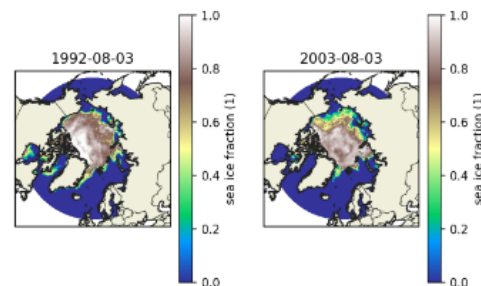
    projection = ct.cdsplot.crs.LambertAzimuthalEqualArea(central_latitude=90)
    fig = ct.cdsplot.figure(nrows=1, ncols=2, subplot_kw={'projection': projection}, adjust_kwangs={'hspace': .4})
    ct.cdsplot.geomap(
        ct.cube.select(sic_1992, lat=(55., 90.)), fig=fig, figcol=0,
        title=time_92, pcolormesh_kwangs={'cmap': 'terrain'})
    ct.cdsplot.geomap(
        ct.cube.select(sic_2003, lat=(55., 90.)), fig=fig, figcol=1,
        title=time_03, pcolormesh_kwangs={'cmap': 'terrain'})

    return fig
```

Copy Run

Execution status and results

Format maps to allow visual comparison



Copernicus
European Copernicus Data



Version: 3.5.12 - build 3a14702



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EQC of the CDS Toolbox

The EQC function assesses the quality of the CDS Toolbox from multiple angles: tools, workflows, Common Data Model (CDM), application editor, provenance tracking system. This presentation focuses on the tools only.



The EQC framework of the Toolbox aims to:

- ☐ Assess the maturity of the software tools: robust in terms of code versioning and testing and well documented
- ☐ Evaluate the fitness-for-purpose of the software through use cases identified together with the users, assessing the applicability of the Toolbox to specific operations

Software quality assessment is based on the internationally-recognized standard ISO/IEC 9126 and extensions (e.g. ISO/IEC 25010:2011)





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EQC of the CDS Toolbox

Documentation

Code versioning
and testing



Toolbox data
model
compliance

Tool F4P

DOCUMENTATION AND DESCRIPTION

Is the tool container-
based?

Yes

Accessibility of the
source code

The source ...

Source code

Github.com/ES/...

**Independent Evaluation on Code
Versioning and Testing and**

Description of code testing with
maturity matrix

Code	Basic Check	Functionality (suitability) unit testing and integration testing	Performance through standardized tests
Information Availability (a)			
Information Appropriateness (b) (if script based)			
Information Appropriateness (c) (if container based)			
Functionality 1 (d)			
Functionality N (d)			

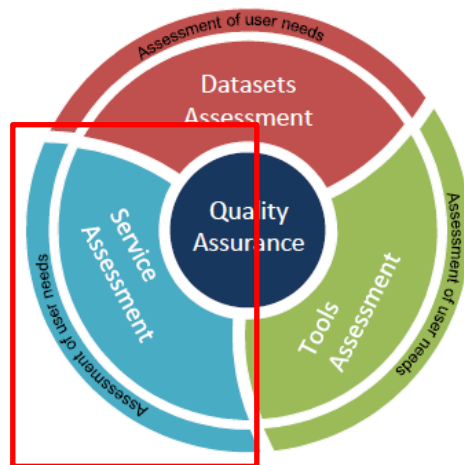
☐ A web page is built
dynamically, showing the
information stored and
managed by the CMS

☐ The user selections form
the query to interrogate
the database managed
by the CMS.



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EQC OF THE CDS SERVICE

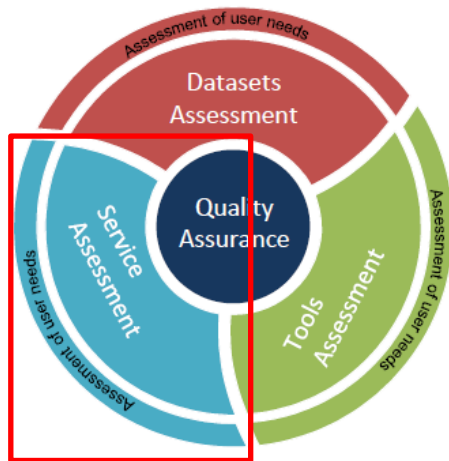




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EQC of the CDS service

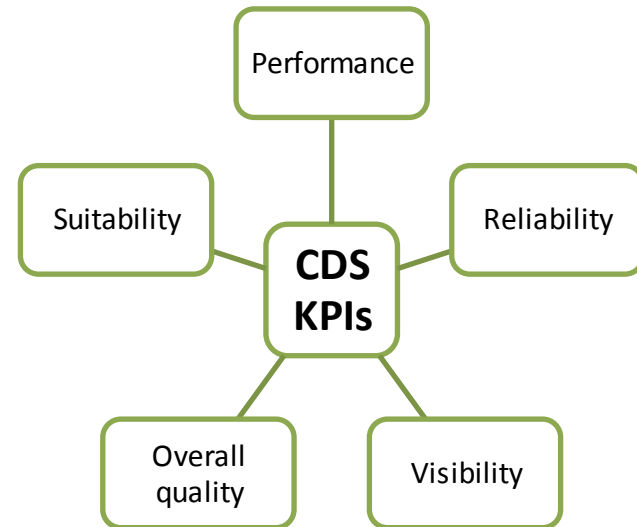
The EQC function measures and reports the technical quality of the CDS service (e.g. system availability, response time).



In particular, monitoring of the CDS infrastructure is based on:

- ☐ A set of Key Performance Indicators (KPIs)
- ☐ On-line rating widgets to monitor user satisfaction
- ☐ Development of a web dashboard hosting the KPIs and widgets statistics for information of the operators

The KPIs have been inspired by the internationally-recognized standard ISO/IEC 25010 and 25011





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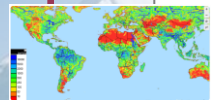
E Q C F O R S I S



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EQC for the SIS

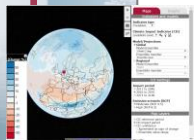
The **EQC** function provides an overarching quality assurance service for all SIS activities and outputs:



SIS datasets: provide information about the quality, user relevance and fitness-for-purpose



SIS tools and workflows: assessment of quality of tools and workflows, ensuring they uphold the required standards



SIS applications: assessment of quality and fitness-for-purposed of applications for interacting with SIS datasets and workflows



SIS documentation: ensuring that all documentation, including user guides, tutorials, and webpages, provide users with the information required to assess its suitability for their needs



WATER
MANAGEMENT



AGRICULTURE &
FORESTRY



TOURISM



INSURANCE



TRANSPORT



ENERGY



HEALTH



INFRASTRUCTURE



DISASTER
RISK
REDUCTION



COASTAL AREAS

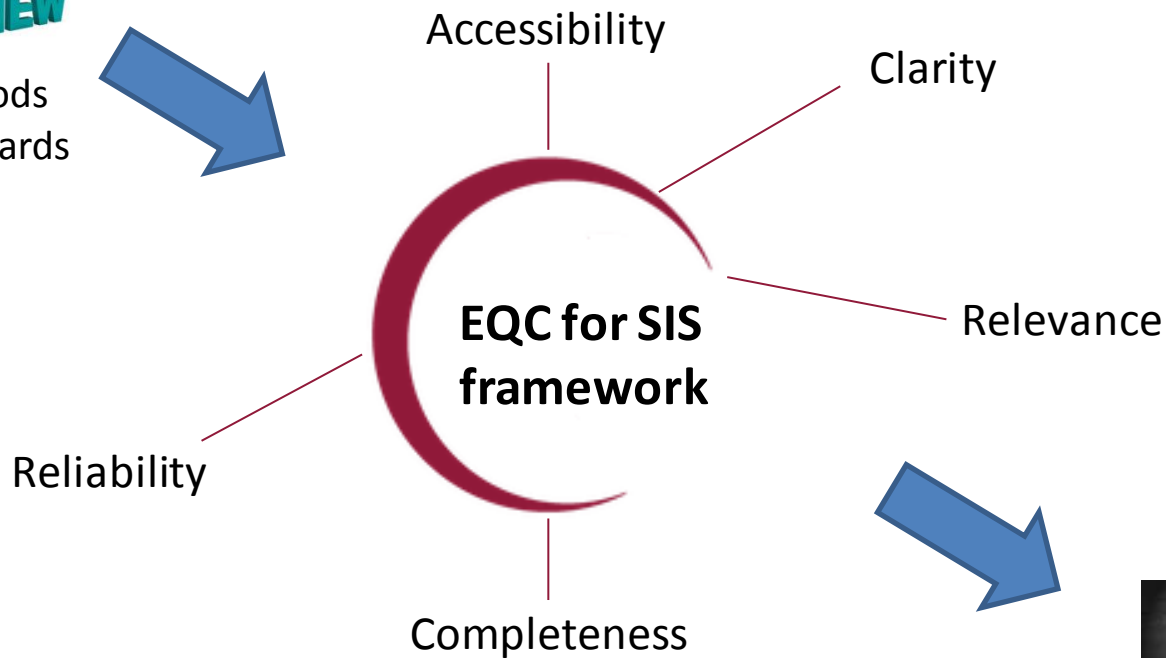
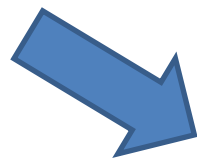


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EQC framework for the SIS



of methods
and standards



Definition of
operational





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EQC framework for the SIS



EQC for SIS framework

- ☐ EQC for SIS will work closely with SIS contractors to iteratively complete a **Quality Assurance Template (QAT)**
- ☐ Once complete and approved, the QAT will become a published **Quality Assurance Reports (QAR)**
- ☐ Each criterion in the QAT will be ranked in terms of completeness of information provided, for example:

Not Assessed	Missing	Basic	Intermediate	Good	Excellent
--------------	---------	-------	--------------	------	-----------

- ☐ QATs and QARs will be stored in the online EQC **Content Management System (CMS)**
- ☐ QAR information will be **published online** so that it is accessible to users
- ☐ Aim is for **users to have the information they need** to use the climate products and services for their own purposes



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EQC OF THE SIS DATASETS

Climate data for the European energy sector from 1979 to 2016 derived from ERA-Interim

[Overview](#)

[Download data](#)

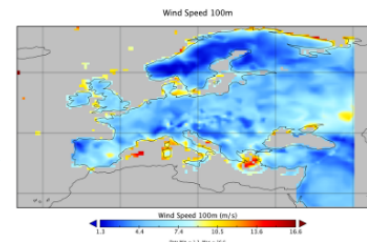
[Documentation](#)

The dataset contains **wind speed, precipitation, relative humidity, global horizontal irradiance, sea level pressure, air temperature, snow depth and dewpoint depression** near-surface data relevant to energy industry for the European domain for the period 1979-2016.

The dataset is mostly derived from 6-hourly ERA-Interim reanalysis dataset by bias adjusting against observations using different methods. Data are then aggregated on daily, monthly, seasonal and annual averages. For wind speed, the field at 10 metres was bias-adjusted and then extrapolated to 100 metres using a stability-dependent logarithmic scaling.

The dataset was generated by one of the Sectoral Information System (SIS) proof of concept contracts led by the University of East Anglia to the the Copernicus Climate Change Service (C3S). The aim of the European Climatic Energy Mixes (ECEM) contract – which worked in close collaboration with a set of prospective users – was to enable the energy industry and policy makers to assess how well different energy supply mixes in Europe will meet demand, over different time horizons from seasonal to long-term decadal, focusing on the role climate has on the mixes.

More details about the product are given in the Documentation section.



Example SIS dataset in the CDS catalogue





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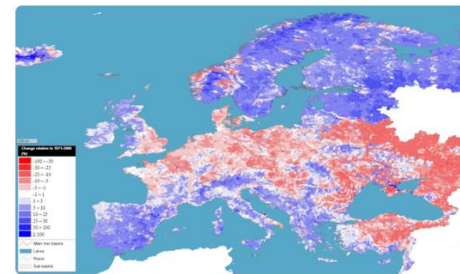
EQC of the SIS datasets

QAR of SIS
datasets

SIS datasets are expected to encompass ECVs and sectoral Climate Impact Indicators (CIIs). The results of the quality assessment of SIS datasets will be provided as **QARs**. The QAR is made of information from the SIS contractors, based on **relevance, accessibility, clarity, completeness** and **reliability**.

Key quality assurance aspects include:

- ☐ Methods used are appropriate, **referenced**, and meet required standards
- ☐ Datasets, including **metadata**, are consistent and have appropriate coverage
- ☐ **Uncertainty**/quality information provided, verification/**validation** has occurred
- ☐ Easy access to relevant, usable and credible **documentation** (e.g. ATDB, user guide)
- ☐ **Ease of access** and use of dataset, including conforming to accessibility guidelines







As with the CDS datasets, the SIS QARs will be made available through the ***synthesis table*** integrated in the CDS catalogue



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EQC OF THE SIS APPLICATIONS

All	Applications	Datasets
	Navigation: Cost of Arctic Route (Projections) Due to global warming and the continuous shrinking of Arctic sea ice, maritime transport in the Arctic region has increased dramatically since early 2000s. For Arctic shipping, the so-called Northeast...	
	<u>Navigation: Arctic Route Availability (Projections)</u> Sea ice projections allow us to estimate the period of the year during which the north-east passage will be effectively navigable. This is for the next hundred years. With such information sea traders...	
	Navigation: Iceberg presence (climatology/monthly) The iceberg presence indicator intends to quantify the risk of encountering an iceberg in the north Atlantic. A release, drift and melting model was implemented allowing to track the progress of the I...	
	Application Historical Simulations of Fire Danger forecasted by the European Forest Fire Information System This dataset contains modelled daily data from the European Forest Fire Information System (EFFIS) of fire danger using weather forecast from historical simulations provided by ECMWF ERA5 reanalysis....	

Example SIS applications in the test CDS Catalogue



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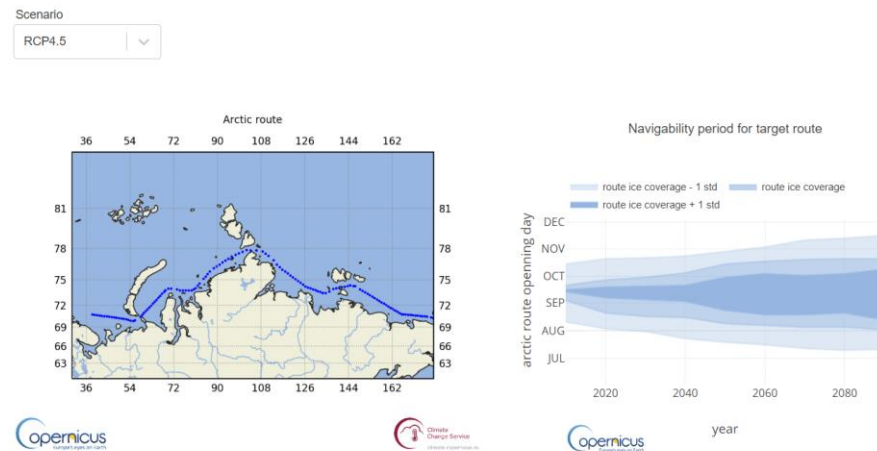
EQC of the SIS applications

QAR of the
SIS
applications

SIS applications allow users to visualise datasets, providing an interactive user interface for running SIS workflows. The results of the quality assessment of SIS applications will be provided as a **QAR**. The QAR is made of information from the SIS contractors, based on **relevance, accessibility, clarity, completeness and reliability**.

- ☐ SIS applications are a new feature yet to be integrated in the CDS
- ☐ Proposed applications are present in the test CDS environment
- ☐ EQC assessment will occur in the test environment
- ☐ The application catalogue entry provides a description and documentation
- ☐ Once the EQC QAR is approved, the application can be published in the public CDS

Arctic route availability on projection



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European Copernicus

Climate
Change Service
at ECMWF and Copernicus

copernicus
European Copernicus

ECMWF

Copernicus
Europe's eyes on Earth



European
Commission



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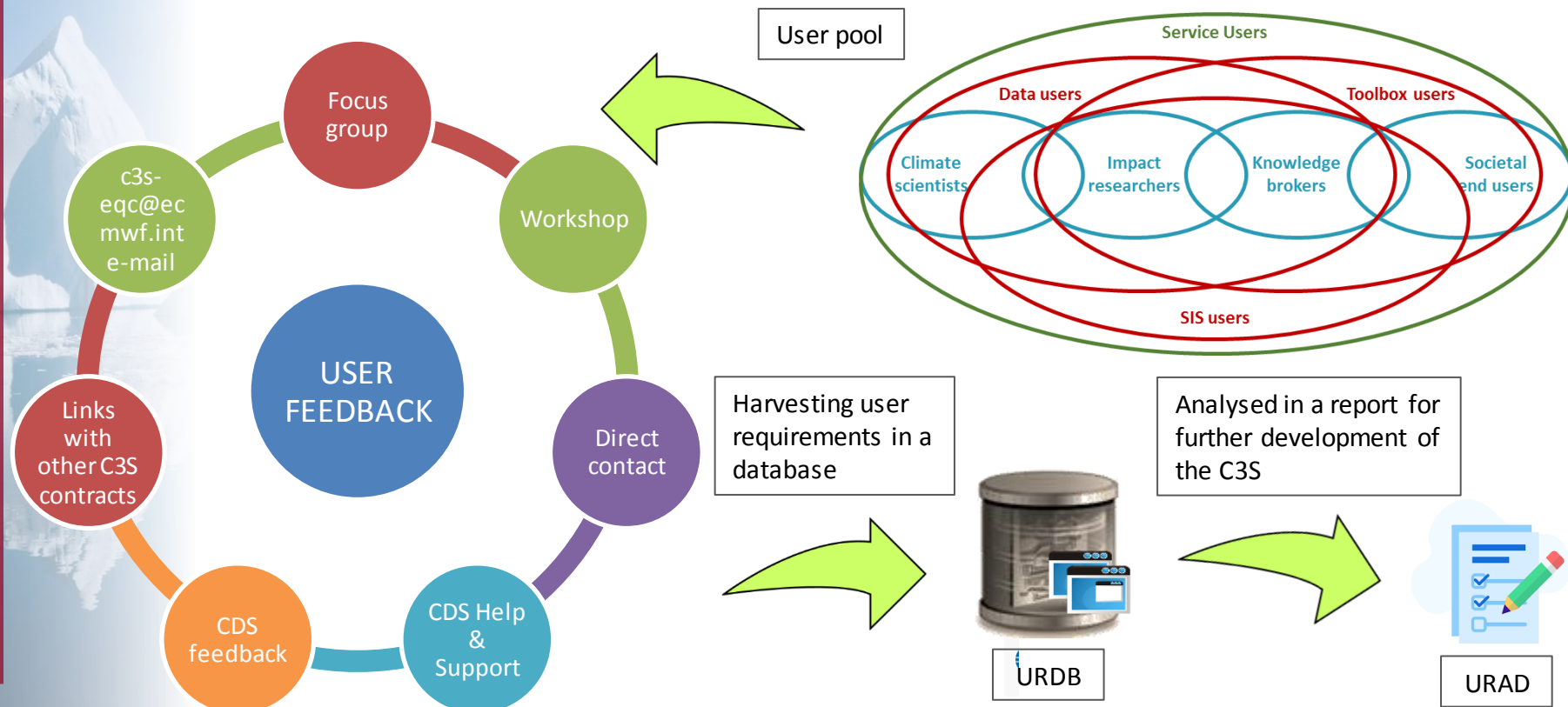
USER NEEDS



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User needs

As the C3S is a user-driven climate service, user feedback is central to develop recommendations for improvement and expansion of the overall C3S (CDS data, Toolbox and SIS products)





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User needs

As the C3S is a user-driven climate service, EOC undertakes a comprehensive user requirement assessment to ensure that **C3S meets the needs in terms of quality information** of its wide range of users

User engagement activities aim to:

- ❑ **Develop recommendations...** to enrich and expand CDS/SIS datasets and products
- ❑ **Improve data and service quality** ... for consistency and accessibility
- ❑ **Adapt C3S...** to the evolving needs of the users

Quality Assurance for the Climate Data Store

Help us create the Climate Data Store (CDS) that works for you

Quality Assurance for the Climate Data Store

Improving quality, consistency and accessibility

Climate Data Store

Climate data at your fingertips

The Climate Data Store (CDS) makes information about the past, present and future climate freely available, and functions as a one-stop shop for users to explore climate data.

4 How we gather user requirements

- Through the feedback form on the CDS website.
- Through the help and support function on the ECMWF website.
- Through direct interaction with users at conferences and events, e.g. through surveys and interviews.

5 Do you want to contribute?

To become a user of the Climate Data Store, please register at climate.copernicus.eu. As you intend to register to improve the CDS, send an email to climate@ecmwf.eu.

Find out more

Web: climate.copernicus.eu
 Twitter: @CopernicusECMWF
 LinkedIn: Copernicus Climate Change Service
 Facebook: Copernicus Climate Change Service

Contact: André Chénier (Senior Technical Officer) andré.chénier@ecmwf.eu

Posters, roll-up banners, factsheets, ...





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Conclusions

- ❑ The EQC function of the C3S provides an **overarching quality assurance service for the whole CDS and SIS** components
- ❑ The EQC framework is building on the legacy of pre-operational projects, guided by traceability and metrological concepts
- ❑ Users can fully understand the status and purpose of data and products, with **all relevant information in one place**, based on the aspects the user deems most important
- ❑ The **homogenization of the EQC information** across all datasets allows to directly use several different datasets
- ❑ The EQC function helps **data producers** to understand which information they need to deliver and how to make their datasets compliant
- ❑ **SIS** climate indicators, workflows and applications are monitored to guarantee their quality and fitness-for-purpose
- ❑ **Users are central** for the development and expansion of the C3S





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THANK YOU

C3S_511, C3S_512 and C3S_513 are service contracts funded by the Copernicus Programmes and operated by ECMWF

